ORBITAL/SUB-ORBITAL PROGRAM 2 (OSP2)

ATTACHMENT 2.B

TECHNICAL REQUIREMENTS DOCUMENT

PEACEKEEPER-CLASS

TARGET LAUNCH VEHICLE CONFIGURATION

(PKTLV)

DRAFT 1

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1.0 SCOPE

1.1 Objective

The Government's objective is to utilize excess Peacekeeper (PK) assets to provide a launch capability to deliver single or multiple payloads on ICBM trajectories. To support this objective, PK motors, shrouds, interstages, and other equipment will be made available as GFP. Primary use is expected to be to provide targets for ballistic missile defense systems testing. However, any test program requiring a Peacekeeper-class ballistic missile launch may be supported.

1.2 Overview

This document defines performance requirements for a launch system capable of placing a variety of payloads on typical ICBM trajectories. The baseline configuration is a 3-stage launch vehicle using the PK shroud to provide protection to the payload. An alternative configuration (Option 3, Appendix A) supports an unshrouded RV.

Payloads may consist of multiple targets including one or more Reentry Vehicles (RV's). The targets and associated AVE will be mated to the Launch Vehicle payload interface. The typical mission requires extensive maneuvers after stage 3 burn-out to deploy multiple payloads in specified directions.

Performance requirements for several "enhanced capability" options are defined in Appendix A to provide additional capabilities. These correlate to CLINs identified in Section___. The Launch Vehicle shall meet these requirements for those missions on which the applicable CLIN is exercised.

Additional payload definition and detailed mission requirements will be provided in a Mission Requirements Document (MRD) issued by the Government at the time authorization to proceed is given for each mission.

2.0 APPLICABLE DOCUMENTS

2.1 Compliance Documents

The documents listed below shall be complied with to the extent specified in the column entitled “Tailored Application”:

Number/Date	Title	Tailored Application
2.1.1 ER/WR 127- 1 31 Oct 1997 Change Pages 23 Oct 2000	Eastern and Western Range, Range Safety Requirements	As Tailored with Range Safety approval
2.1.2 IRIG Standard 106-96	Telemetry Standards	

3.0 REQUIREMENTS

3.1 System Description

The OSP-2 PK based Target Launch System consists of the PK Launch Vehicle (LV) and the Ground Segment.

3.1.1 Launch Vehicle

The Government will make available as GFP Peacekeeper motors, interstages, shrouds, and associated equipment including Range Safety systems. The stage 1,2 and 3 motors and interstages will be certified for flight and delivered to the launch site by the Government. Flight-worthiness of other components shall be Contractor responsibility. Although Peacekeeper fourth stages will be made available as GFP; note that the PKTLV baseline configuration will not require a fourth stage with axial propulsive capability and may in fact prohibit axial thrust due to START considerations. An axial propulsive capability will be required under Enhancement Option 1 (See Appendix A) if the option is exercised.

The Contractor shall provide hardware and software to accomplish the following functions:

- Payload interface
- Guidance and control
- Instrumentation and telemetered data
- Airborne range safety functions
- Attitude control after final stage burn out.
- Additional propulsion capability as required

3.1.2 Ground Segment

The ground segment consists of:

- Contractor furnished Support Equipment consisting of all equipment required to process, integrate, check-out, and launch the LV.
- Peacekeeper ground support equipment and handling equipment provided GFP as available.
- Launch Facilities furnished by the Government. Modifications if necessary shall be furnished by the Contractor.
- Optional contractor provided launch vehicle environmental protection system for sites without environmental protection. (Option A-5, Appendix A).

3.2 Characteristics

3.2.1 Payload Interfaces

The Launch Vehicle shall be designed to accommodate a variety of payload sizes, shapes and interfaces. The Contractor shall develop a standard payload interface, addressing both electrical and mechanical interface requirements, and which meets the requirements specified herein. Once an acceptable interface is established, the Contractor shall support all future payload configurations that comply with the standard interface. Payloads may vary in quantity, weights, structural characteristics, electrical interfaces, and deployment requirements, but the physical interfaces (wires, connectors, bolt patterns) will not be changed.

3.2.1.1 Mechanical

3.2.1.1.1 Envelope

The LV shall support payload configurations that fit within the existing Peacekeeper shroud.

3.2.1.1.2 Access

The Launch System shall provide access to the payload after shroud mate without removing the shroud or breaking electrical connections. The minimum opening size shall be 100 square inches. Access size and location shall be defined in the ICD.

3.2.1.1.3 Interface

The LV shall provide a standard non-separating structural interface on which to mount the payload assembly.

3.2.1.1.4 Mass Properties

The LV shall accommodate a total payload mass up to 6600 lbs. The LV shall provide the capability of accommodating any payload weight up to its maximum capability.

3.2.1.2 Electrical Interfaces

3.2.1.2.1 Command, Control, and Monitor

The Launch Vehicle shall provide umbilicals and cabling to allow the Payload Support Equipment to provide power and communicate with the payload until launch. Up to 128 lines (copper paths) shall be provided.

3.2.1.2.2 Launch Vehicle to Payload Commands

3.2.1.2.2.1 Serial Communication

Communications between the Front Section and the payload shall be made through redundant standard serial UART protocols using RS422 drivers. Commands from the FS to the payload shall be issued three times in succession using hexadecimal format thus allowing up to 256 different commands.

3.2.1.2.2.2 Electrical Discretes

The LV shall provide the following circuits based on 1.5 ohm payload loads:

Quantity:	4 circuits
Minimum current:	5 amp
Timing accuracy:	10 millisec
Minimum Duration:	35 millisec
Simultaneity:	Individually or up to 4 discretes with a tolerance of 1 millisec
Safing	Provide safing in accordance with Paragraph 2.1.1.

The circuits shall also be capable of providing 28 volts $\pm$ 4 volts to high resistance loads.

3.2.1.2.2.3 Verification

The FS shall verify receipt of commands sent to the payload. The payload will provide a direct return circuit for command signals back to the FS to verify receipt of the commands.

3.2.1.2.3 GPS Timing Signal

The front section shall provide a GPS based one pulse per second timing signal to the payload with a minimum active high pulse width of .02 millisec. This signal shall be optically isolated at the payload and shall be capable of driving a 5 Vdc, 1 mA load.

3.2.1.2.4 Antenna Utilization

The Launch Vehicle (LV) shall provide a re-radiation system to permit transmission of Payload RF links through LV antennas. This shall include upper and lower S-band, and C-band. The payload will provide the signals through hard-lines to the LV interface. The LV shall provide hardware for combining the signals and coupling them to the LV antennas. S-band links are required throughout flight. The requirement for the upper C-band link is to provide the capability in the pre-launch configuration with a goal to continue to provide it through flight until shroud removal.

The LV shall also provide GPS (L-band) signals to the payload until shroud removal, using LV GPS antennas and hard wiring the signals to the payload interface. The level shall be at least -128 dBm minimum.

3.2.2 Payload Environments

3.2.2.1 Shock

Shocks induced at the payload interface from all CFE sources shall not exceed the following Maximum Predicted Environment (MPE):

MPE Level

Frequency (Hz)	**SRS** (g's Peak)
20	13
200	100
800	733
1500	2250
10000	2250

Shock environments from all sources (including GFP) shall be determined by the Contractor at the payload interface.

3.2.2.2 Dynamic Environments

The following environments shall be determined by the Contractor and defined in the ICD for the applicable mission.

- Vibration
- Transient loads
- Steady state acceleration

3.2.2.3 Environmental Control

3.2.2.3.1 Thermal

During ground processing prior to launch, the payload temperature shall be maintained within 60 to 100 deg F neglecting internal heating sources from the payload.

3.2.2.3.2 Contamination

Provisions shall be made to facilitate the implementation of a continuous clean dry nitrogen purge if required. (See Appendix A for enhanced capability Option 3).

3.2.2.4 Plume Effects

The LV shall minimize plume effects from all propulsion sources in terms of forces applied to the payloads after deployment and contamination prior to and after deployment. Specific requirements, such as ΔV or tip-off, will be defined in the MRD.

3.2.3 Performance

3.2.3.1 Payload Capability

The launch vehicle shall be capable of delivering a 6600 lb payload on a trajectory from VAFB to the following target point:

25 deg N latitude
170 deg E longitude
280 Km altitude
Reentry Flight Path Angle of 20 deg

3.2.3.2 Flight Path Angles

The launch vehicle shall be capable of trajectories resulting in reentry flight path angles from 20 degrees to 40 degrees for other payload weights and ranges.

3.2.3.3 Accuracy

For the reference trajectory specified in Paragraph 3.2.3.1, the primary Reentry Vehicle shall pass through a 3 nmi circle lying in the horizontal plane at the Target Point with a 99% probability. In determining accuracy, errors due to the payload ejection system in velocity magnitude and direction will not be included.

3.2.3.4 Timing

The time from lift-off to arrival of the primary Reentry Vehicle at the target altitude shall be controlled within $\pm$ 1.5 seconds, 3-sigma.

3.2.3.5 Stage 4 Separation

After burn-out of stage 3, the stage 4 shall separate from the stage 3. A selectable velocity up to 50 ft/sec nominal shall be applied to the stage 3 relative to the stage 4 at separation. The velocity vector shall be controlled within 10 degrees of the nominal direction as defined in the MRD. Note that for Option A-1 (Appendix A, PBV), the propulsion capability of the stage 4 can be used to provide the separation velocity. However, the baseline configuration must provide the separation velocity by adding velocity to the stage 3 or through mechanical devices that impart velocity to both stage 3 and stage 4 in accordance with their masses.

3.2.3.6 Stage 4 Disposal Option (Appendix A, Option A-4)

3.2.3.7 Attitude Control

The Launch Vehicle shall be capable of performing maneuvers to deploy up to 10 targets with 40 deg maneuvers in multiple axes required between deployments, and maintain attitude control throughout the exoatmospheric portion of the trajectory. Specific deployment requirements will be specified in the MRD for the respective missions. These requirements may be specified in terms of:

- A “target scene” showing the relative locations of deployed objects as viewed by the interceptor at a specific time;
- Spacing requirements between objects at some point in the trajectory
- Deployment directions defined in inertial space or in Euler angles

3.2.3.8 Attitude Accuracy

The (Attitude Control System) ACS shall control attitude of the stage 4 within 1 deg 3-sigma, with rates less than 1-deg/sec 3-sigma. Rates induced due to payload deployments shall be minimized.

3.2.4 Telemetry and Instrumentation

The Launch System shall collect and transmit sufficient data during prelaunch and in-flight to assess status, performance, and environments; to meet all Range Safety requirements per Paragraph 2.1.1; and to provide diagnostics in the event of anomalous performance.

3.2.4.1 Navigation Data

The LV shall provide navigation data with an accuracy of approximately 25 m (1-sigma) at 1 Hz intervals.

3.2.4.2 Telemetry Characteristics

The LV shall provide pulse code modulation (PCM) telemetry in accordance with Paragraph 2.1.2. It shall provide a total bit rate of at least 750 Kbps. The telemetry system shall provide flexibility in allocating channel bandwidths. The capability shall be provided to preprogram a time at which telemetry transmission is terminated.

3.2.4.3 Transmitter and Antenna Characteristics

Signal-to-noise margins over 95% of the radiation sphere shall be adequate to achieve a bit error rate no worse than 10^{-6} when transmitting 2100 nmi to a ground station antenna with a gain (G/T) of 15 dB/^{o}K.

3.2.5 Airborne Range Safety Requirements

The Launch System shall include a command destruct system, radar aiding transponder, GPS range safety tracking, and any hardware and/or modifications required for compliance with the applicable portions of Paragraph 2.1.1. Standard Peacekeeper OT&E downstage instrumentation and ordnance will be provided and installed as GFP if desired by the Contractor. Maintaining this hardware (life extension testing for expired ordnance, check-out, etc) shall be the responsibility of the Contractor.

3.2.6 EMI/EMC

3.2.6.1 Emissions

The Launch System shall minimize radiated and conducted emissions that could affect the payload. Specific levels shall be documented in the Payload-to-Launch Vehicle ICD.

3.2.6.2 Susceptibility

The Launch System shall be capable of operating at any of the identified launch sites without adverse effects from the electromagnetic environments. The LV shall also be capable of withstanding EMI radiated and conducted emissions from the payloads. Specific limitations imposed on the payloads shall be documented in the Payload-to-Launch Vehicle ICD.

3.2.7 Launch Availability

The vehicle shall be capable of launching under 90 percentile (annual) wind conditions from VAFB. All other limitations (excluding weather) shall not preclude launching for more than one hour per 24 hour period.

3.2.8 Mission Reliability

The Launch System shall have a design reliability (excluding GFP motors and interstages) of meeting all mission requirements greater than 98 percent. Equipment associated with Range Safety shall meet reliability requirements of Paragraph 2.1.1.

4.0 QUALITY ASSURANCE

4.1 Verification

A verification program shall be conducted to ensure compliance with Section 3 of this document and with the specifications developed by the Contractor. Verification shall be demonstrated through test, analysis, similarity, demonstration, or inspection.

4.2 Development Tests

A development test program shall be conducted to determine flight environments, reduce risks associated with qualifying components to new environments, quantify structural characteristics, demonstrate structural capabilities and mechanical assemblies, and assess interface compatibility among subsystems. The test program shall be structured to account for previously demonstrated flight proven capabilities.

4.3 Qualification Tests

Components shall be qualified (through test or similarity) to show adequate design margins exist over Maximum Predicted Flight (MPF) environments. Dedicated (non-flight) components shall be used for qualification testing in the case of nondevelopmental items unless waived by the Government. Software shall be subjected to a qualification test program to demonstrate compliance with requirements and robustness in off-nominal situations.

4.4 System Integration Test

A system integration test shall be performed with a goal of demonstrating all procedures, verifying SE, LV, booster, payload, and facility interfaces. The nature of the test in terms of flight hardware versus test hardware, location, and functions exercised shall be determined by the Contractor consistent with previously demonstrated performance.

4.5 Flight Proof Tests

Flight proof testing shall be conducted for each mission on flight hardware to demonstrate adequate workmanship. Component and system level testing shall be performed.

4.6 Integration Testing

Integration testing shall be performed with each payload to verify interfaces, demonstrate compatibility, and ensure compliance with the Interface Control Drawing (ICD).

5.0 NOTES

5.1 Verification (Paragraph 4.1)

5.1.1 Analysis

Verification by analysis is a process utilizing techniques and tools such as engineering analysis, statistics, computer and hardware simulations, analog modeling, validation of records, etc to verify requirements have been satisfied. It may be used in lieu of or in addition to testing when:

- Rigorous and accurate analysis is possible
- It is more cost effective than test
- Similarity is not applicable
- Inspection is not adequate

5.1.2 Similarity

Verification by similarity is permitted if it can be demonstrated that the article is sufficiently similar or identical in design to hardware which has been qualified to equivalent or more stringent environmental criteria.

5.1.3 Inspection

Verification by inspection may be used when visual examination of the hardware for compliance with workmanship, quality, and dimensional tolerance is sufficient. It may also include review of manufacturing records.

5.1.4 Demonstration

Verification by demonstration may be used when the qualitative determination of an article's properties can be made by observation under actual or simulated use conditions without special equipment or instrumentation.

5.1.5 Test

When an adequate level of confidence cannot be established by other methods of verification, testing shall be used. Testing employs technical means of measuring performance parameters relative to functional, electrical, mechanical, and environmental requirements.

APPENDIX A

ENHANCED CAPABILITY OPTIONS

This Appendix defines performance requirements for Enhanced capability Options to provide enhanced capabilities corresponding to CLIN _____in section _____.

A-1 Post-Boost Vehicle (Paragraph 3.1.1.2)

Under this option, the stage 4 shall function as a post-boost vehicle (PBV) capable of providing a total delta velocity up to 500 ft/sec with a 3000 lb payload. Thrust shall be controlled to allow multiple target deployments with different velocities controlled by the PBV. The required separation velocity of the stage 3 from the stage 4 defined in paragraph 3.2.3.5 may be provided by the PBV.

A-2 Unshrouded Configuration (Paragraph 1.1)

This configuration supports payloads consisting of a single Reentry Vehicle, other multiple targets, and associated AVE. The RV will be flown unshrouded for most of the trajectory thus requiring a fairing on the launch vehicle to provide a smooth aerodynamic interface with the aft end of the RV. This fairing will enclose other payload components including the RV deployment system, other targets and their mounting hardware, and payload electronics which control the target deployments and payload instrumentation. The launch configuration shall minimize heating effects on the exposed RV during launch.

A-3 Nitrogen Purge (Paragraph 3.2.2.3.2)

The Launch System shall provide a continuous clean dry nitrogen purge to the payload inside the shroud throughout processing up until launch.

A-4 Stage 4 Disposal (Paragraph 3.2.3.6)

The LV shall provide a separation velocity to the Stage 4 up to 50 ft/sec in a controlled direction ($\pm$ 10 deg) to be applied after deployments of payloads are completed.

A-5 Launch Pad Environmental Control (Paragraph 3.1.2)

The Ground Segment shall provide environmental protection and access platforms to maintain the booster within required operating limits and

support launch pad operations. Peacekeeper operating temperature limits are 60°F to 80°F.